Hydrometeor Types From Dual-Pol Radar, Compared to GMI Brightness Temperatures

Daniel J. Cecil, NASA MSFC
Themis Chronis, U. Alabama – Huntsville
Kenneth Leppert II, U. Louisiana - Monroe

Approach

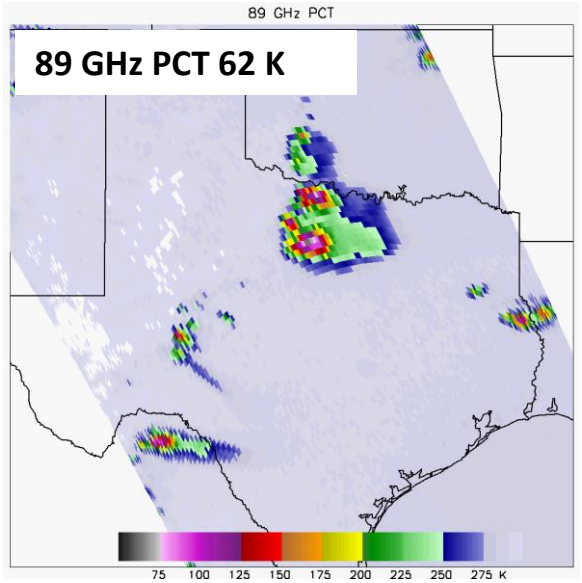
- Use “Virtual Network” (**VN**) of ground-based dual-polarization radars from GPM GV program (mostly Central and Eastern USA), together with GMI brightness temperatures
  - *Database is constructed using a minimum threshold for raining pixels, so inherently biased toward including precipitation*

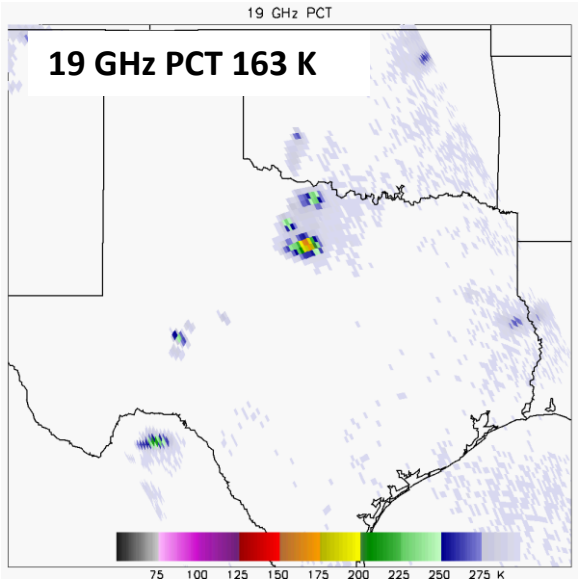
- Hydrometeor ID (**HID**) (e.g., hail, high-density graupel, low-density graupel, aggregates, liquid rain, etc.) derived from dual-pol radar data

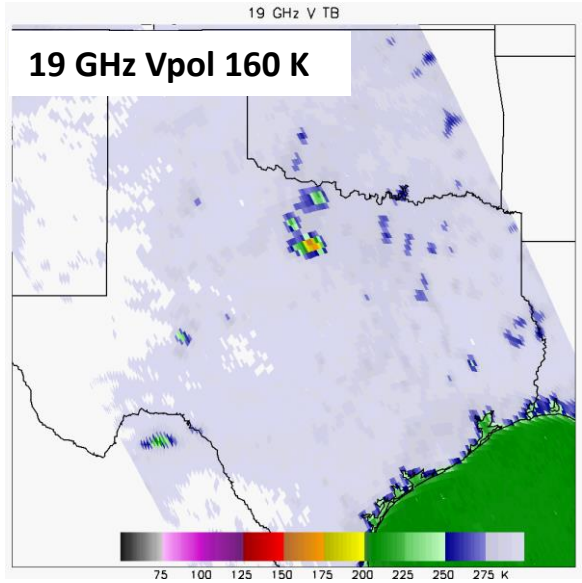
- Construct joint histograms and probability-of-occurrence for different hydrometeor types as a function of brightness temperature in different channels

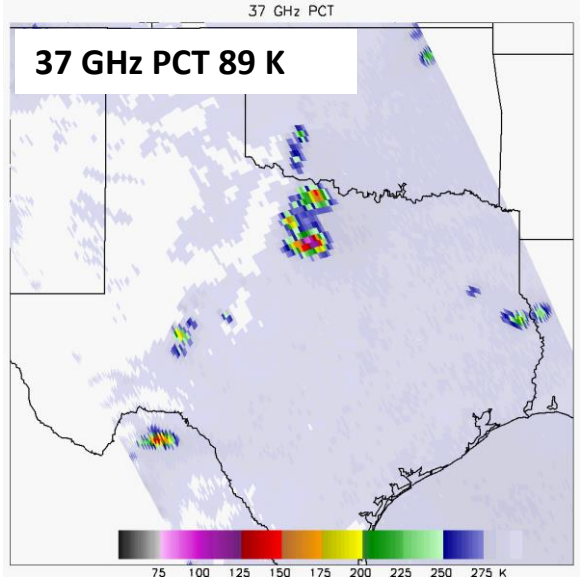
- To facilitate use of low-frequency channels over land, construct polarization corrected temperatures (**PCT**) *(more on that later)*

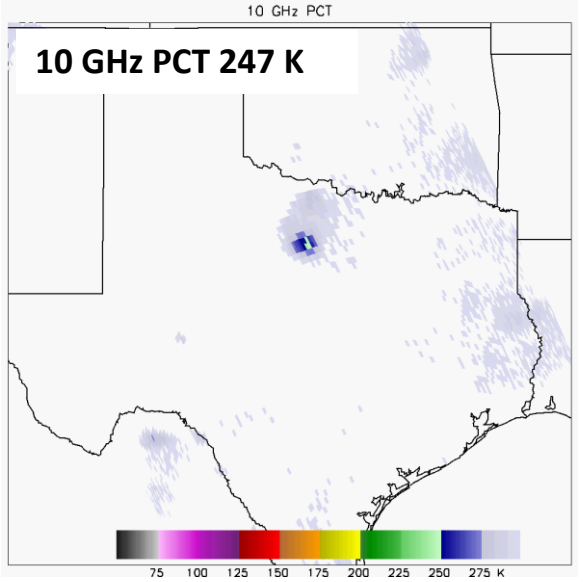
Example – 26 May 2015, west of Ft. Worth

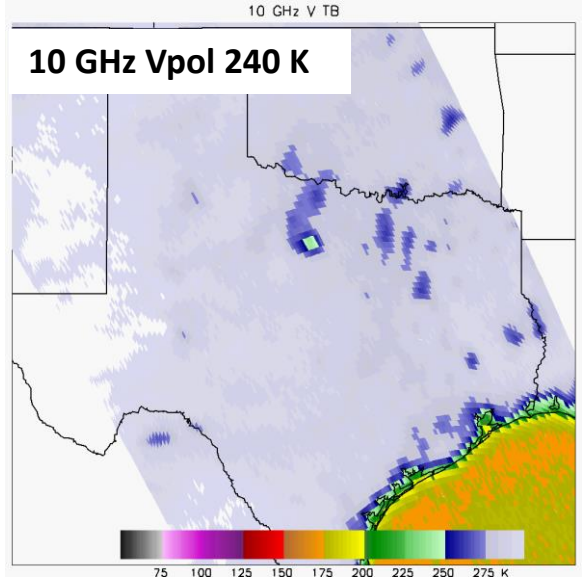






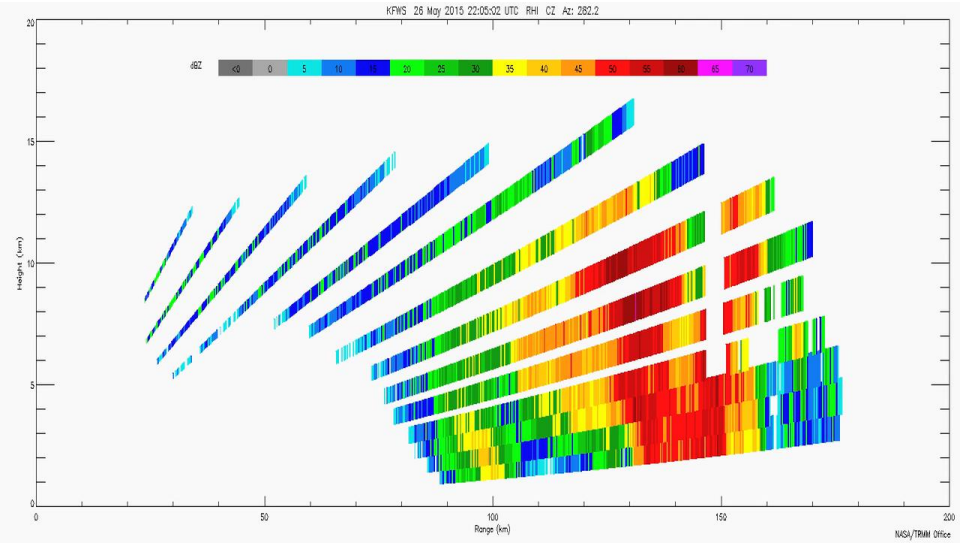


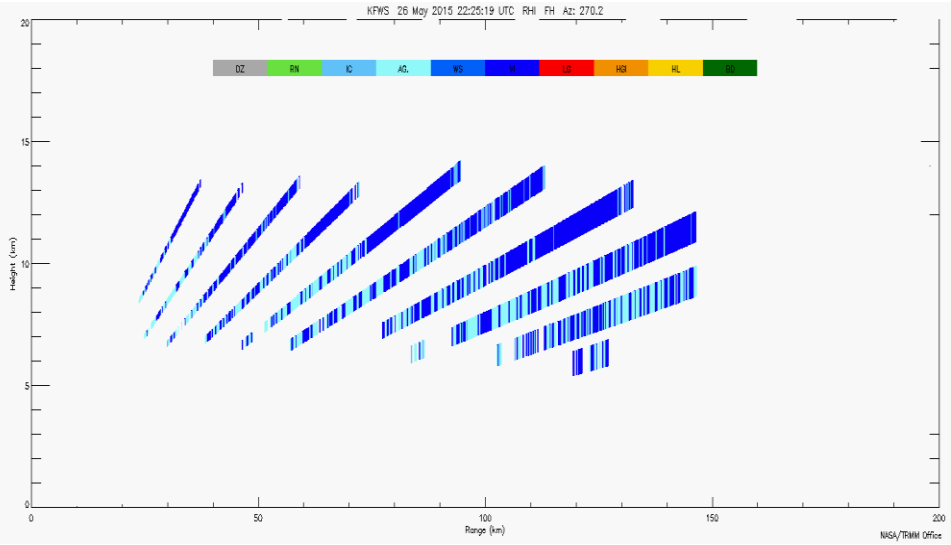


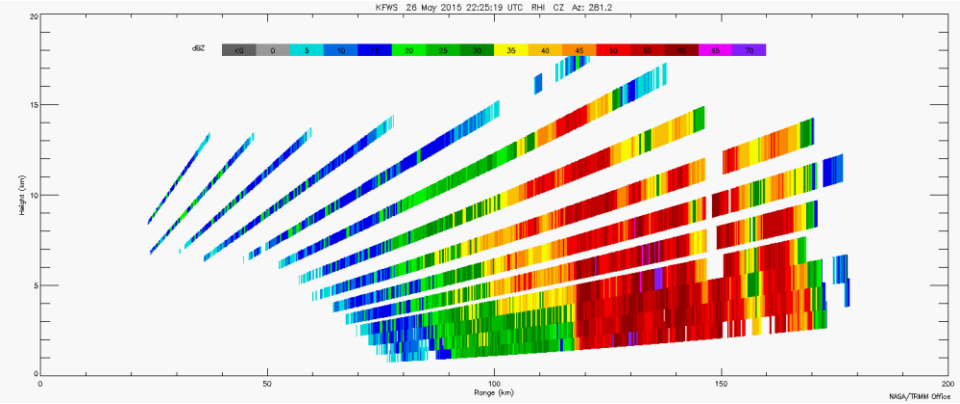


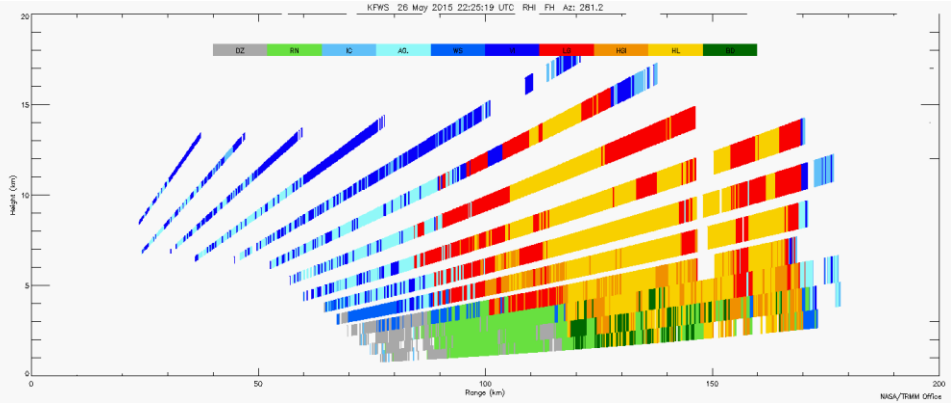
Intense storms in N. Texas stand out; PCT helps distinguish storms from lakes

Radar RHI – 26 May 2015, west of Ft. Worth





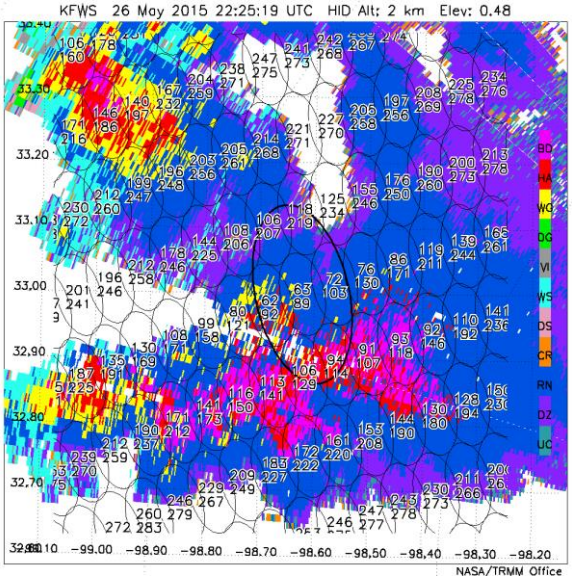


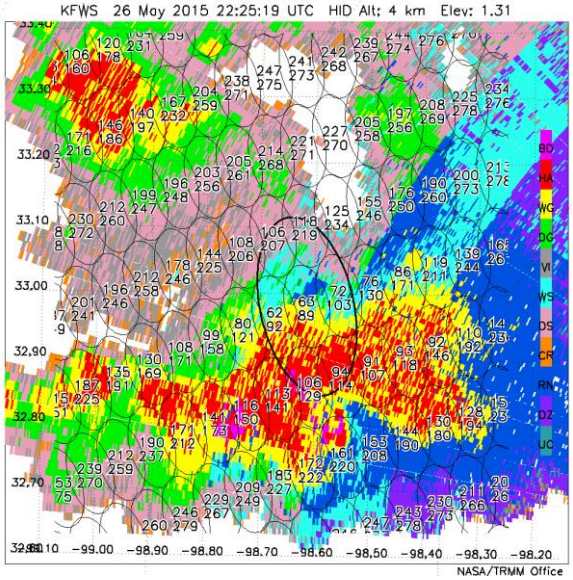


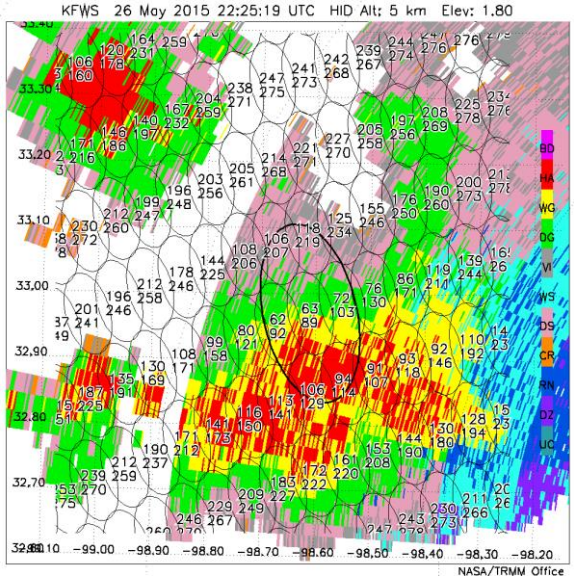
Left: Radar Reflectivity **Right: Hydrometeor Identification (HID)**

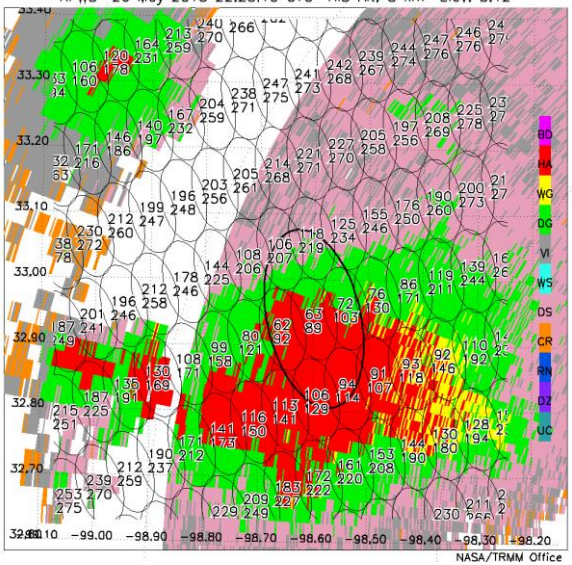
2025 UTC

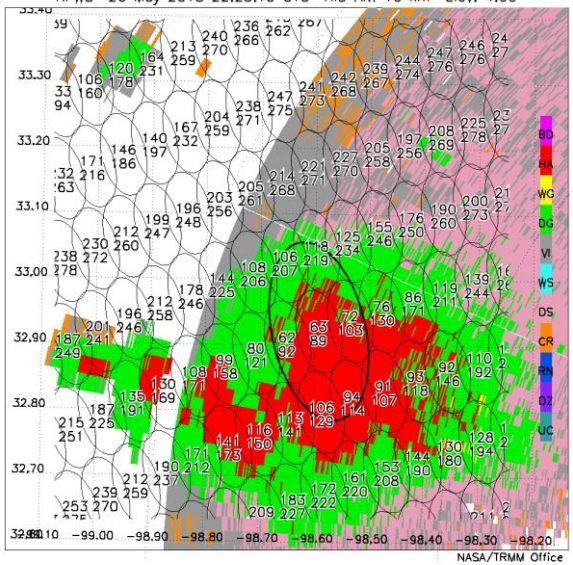
HID with height – 26 May 2015, west of Ft. Worth

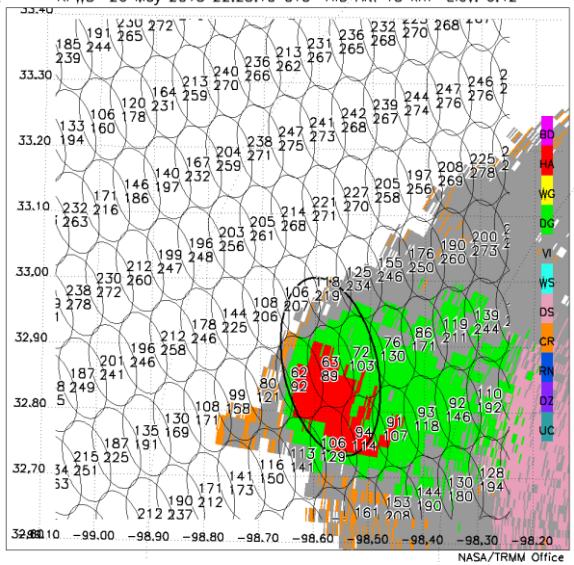










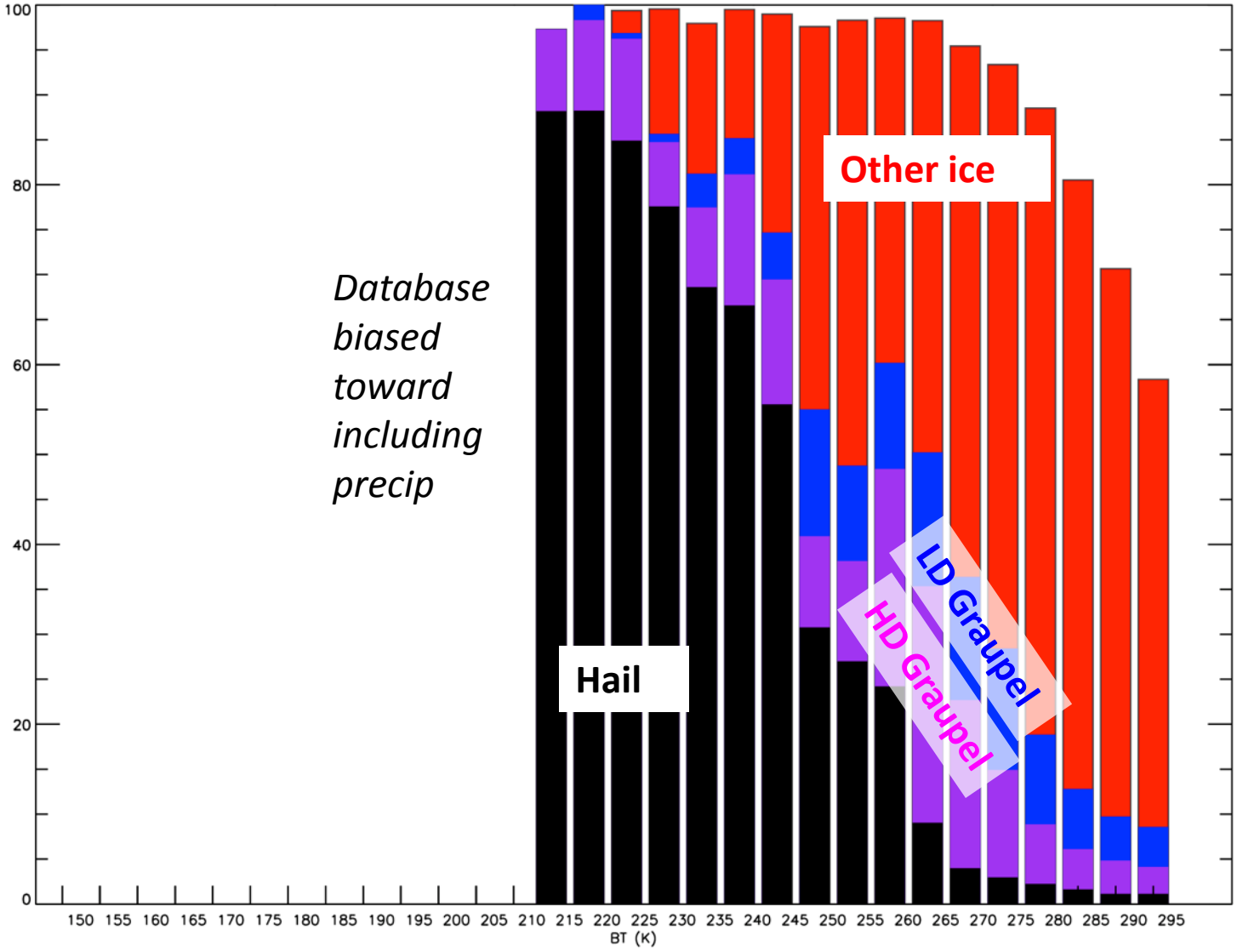


HID shaded; numbers are GMI 89 GHz and 37 GHz PCT; coldest footprint highlighted

HID as function of 37 GHz PCT

Probability that a given HID occurs anywhere in the vertical column

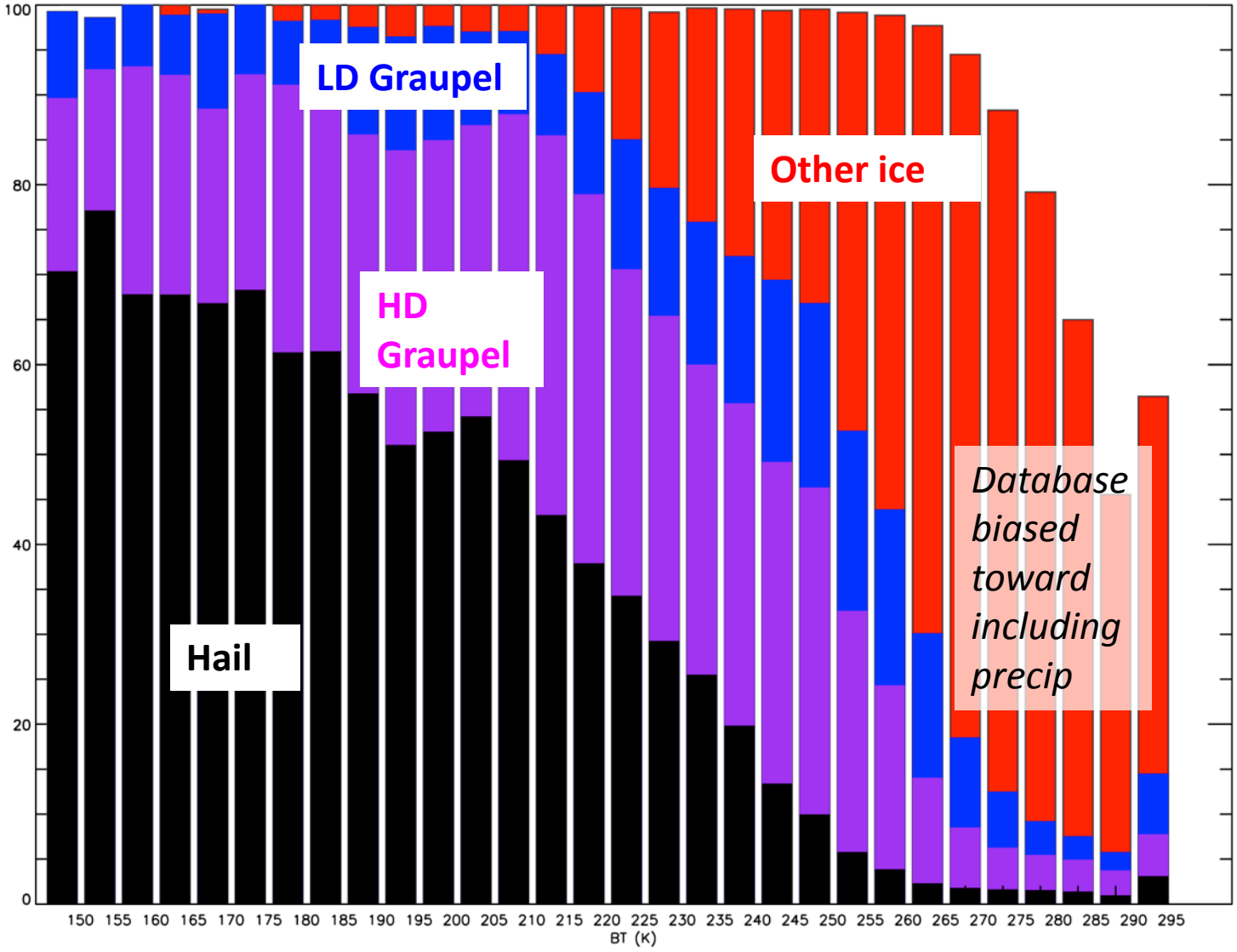
Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.



HID as function of 89 GHz PCT

Probability that a given HID occurs anywhere in the vertical column

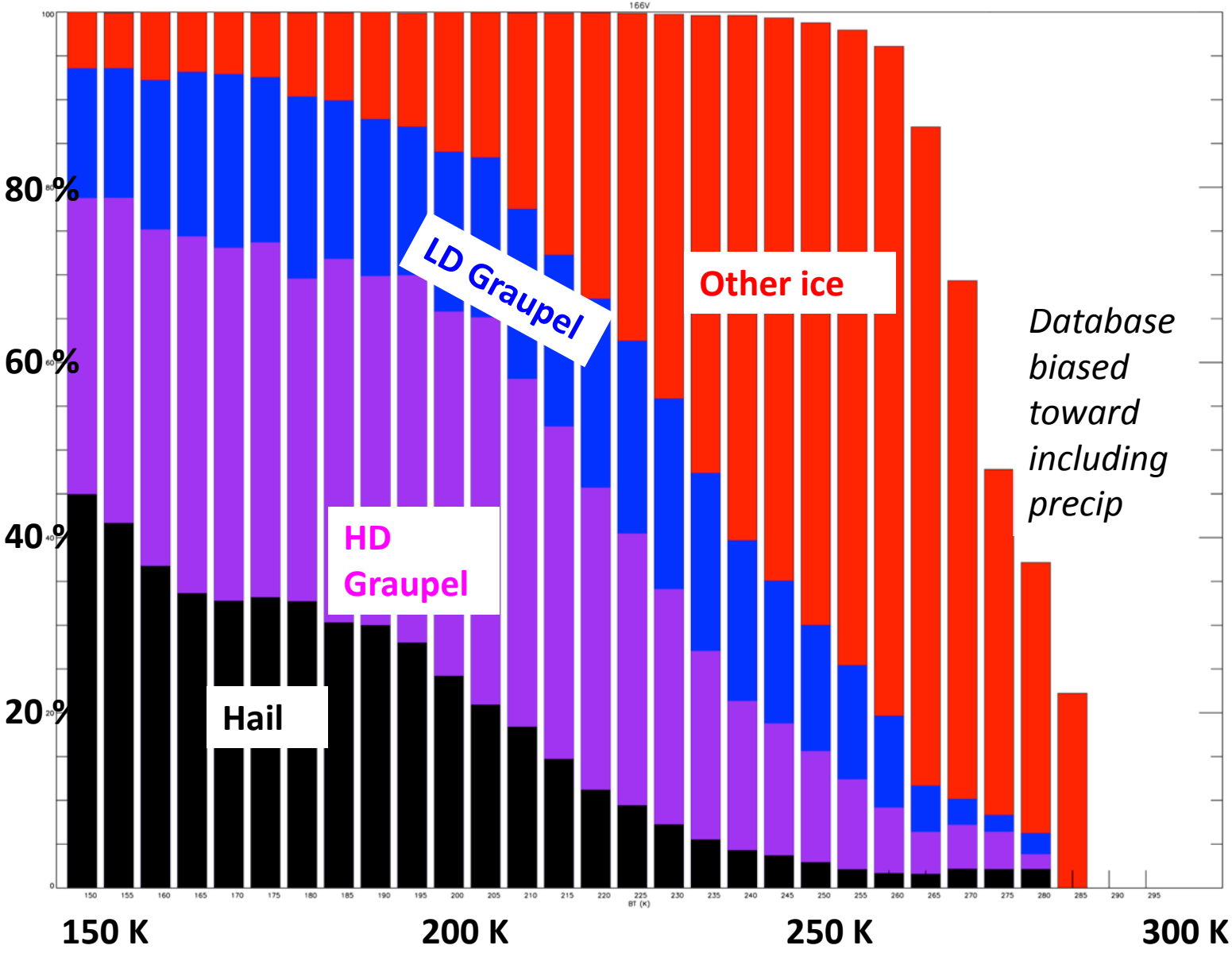
Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.



HID as function of 166 GHz V

Probability that a given HID occurs anywhere in the vertical column

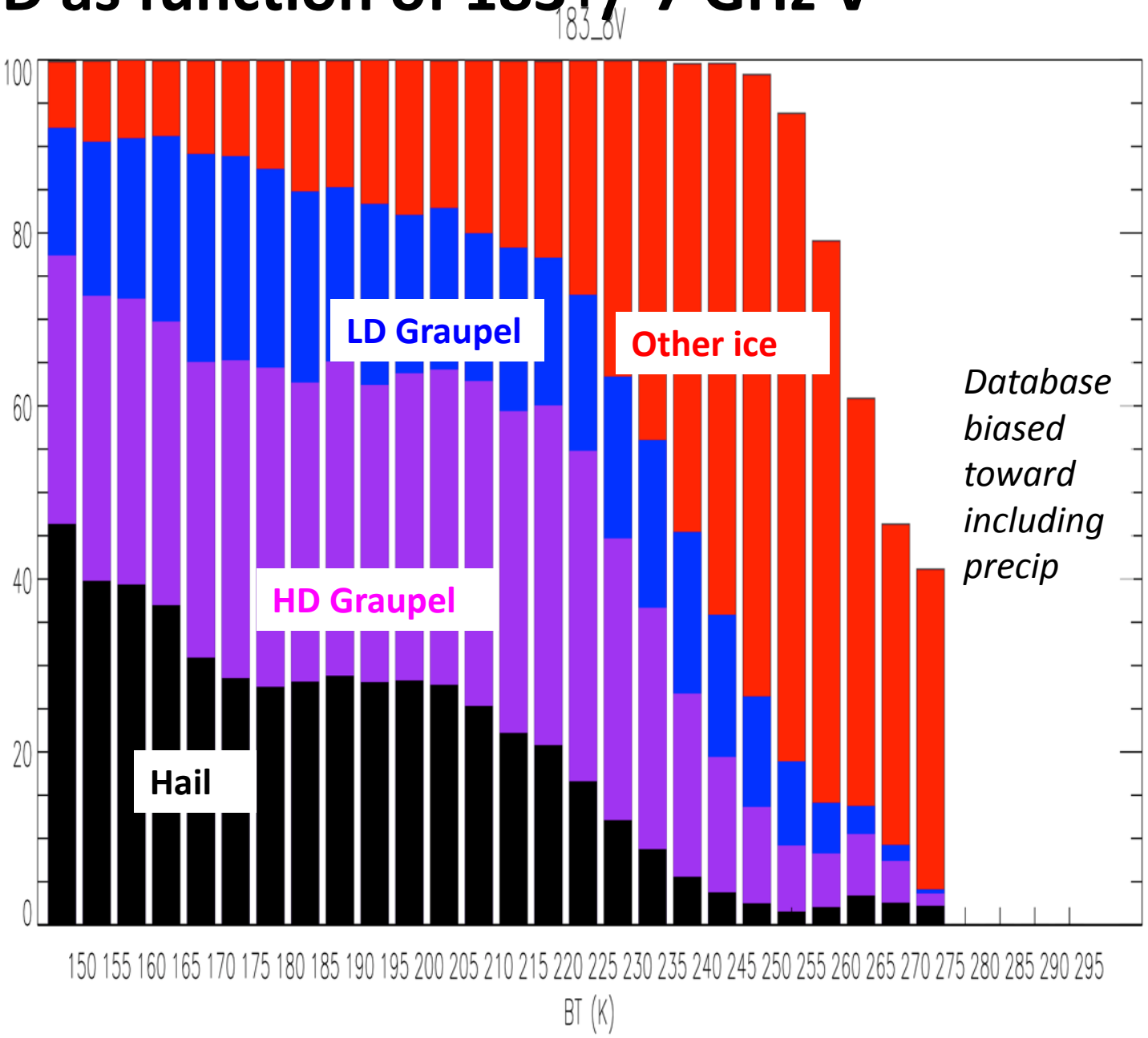
Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.



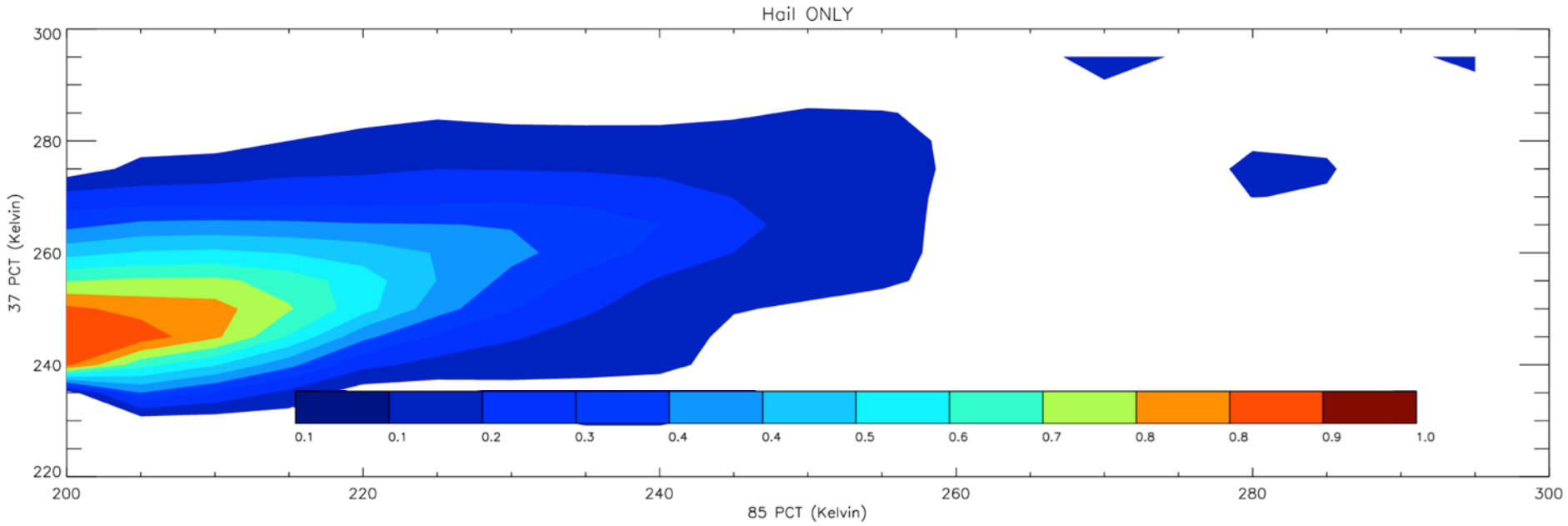
HID as function of 183+/-7 GHz V

Probability that a given HID occurs anywhere in the vertical column

Hierarchy of HIDs applied – first look for hail, then High-Density Graupel, Low-Density Graupel, etc.

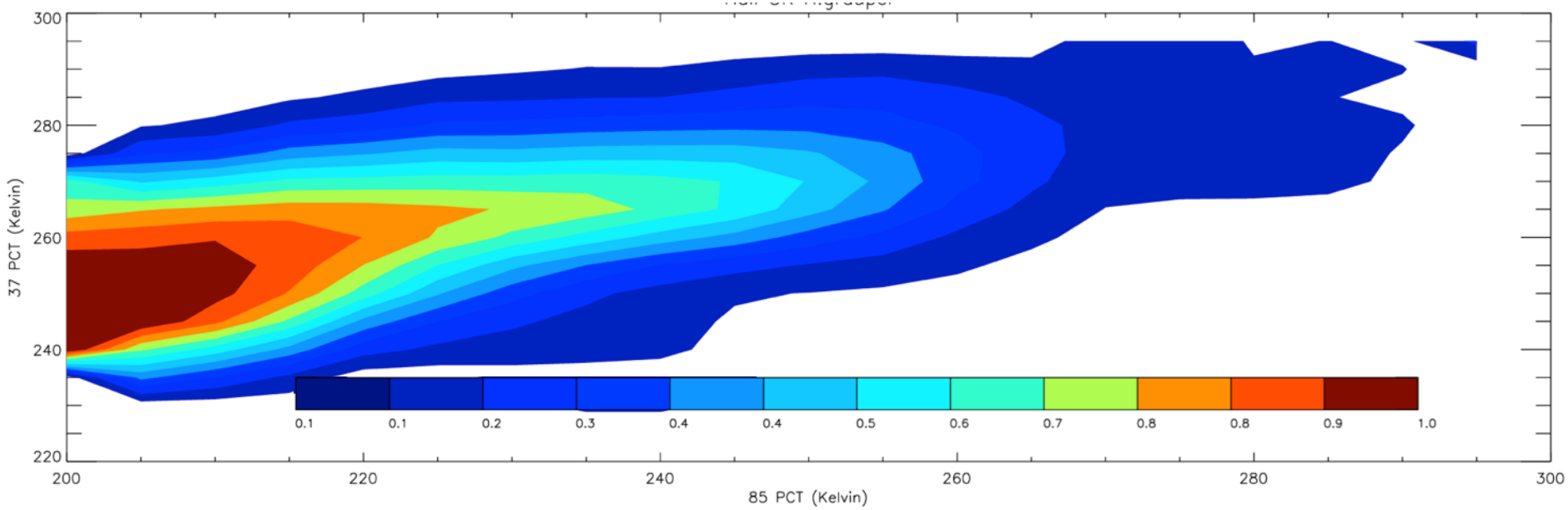


Probability of Hail as function of 89 and 37 GHz PCT



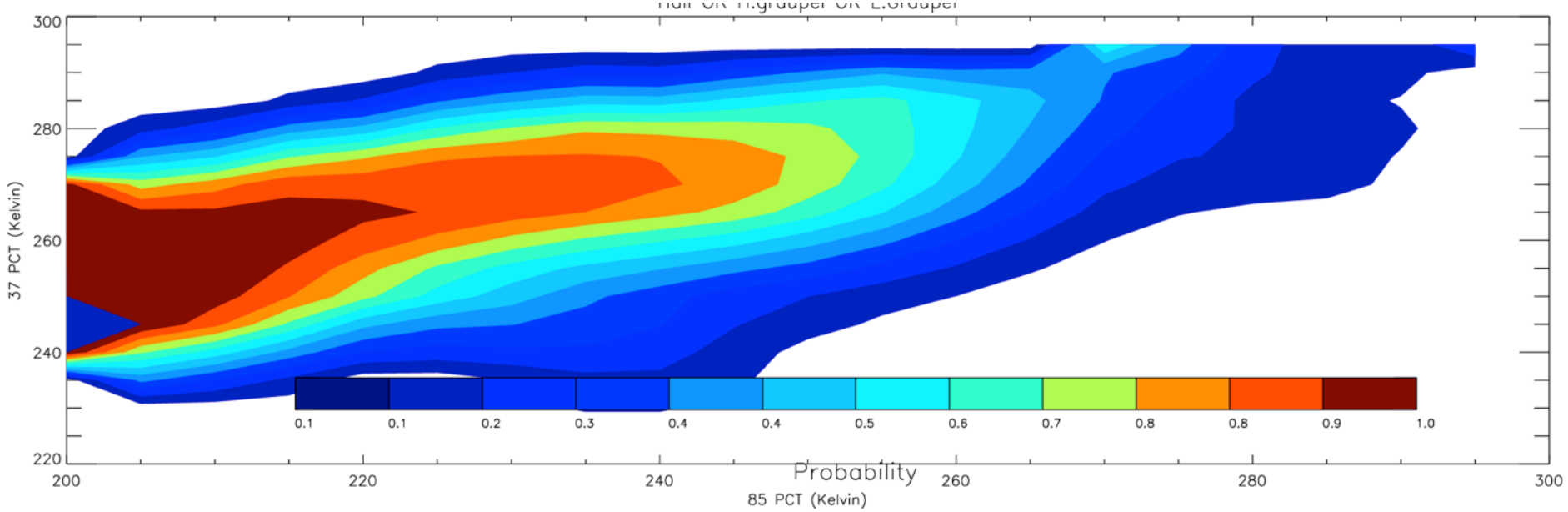
200 K **250 K** **300 K**

Probability of Hail or High Density Graupel as function of 89 and 37 GHz PCT



200 K **250 K** **300 K**

Probability of Hail, High Density Graupel, or Low Density Graupel as function of 89 and 37 GHz PCT



200 K **250 K** **300 K**

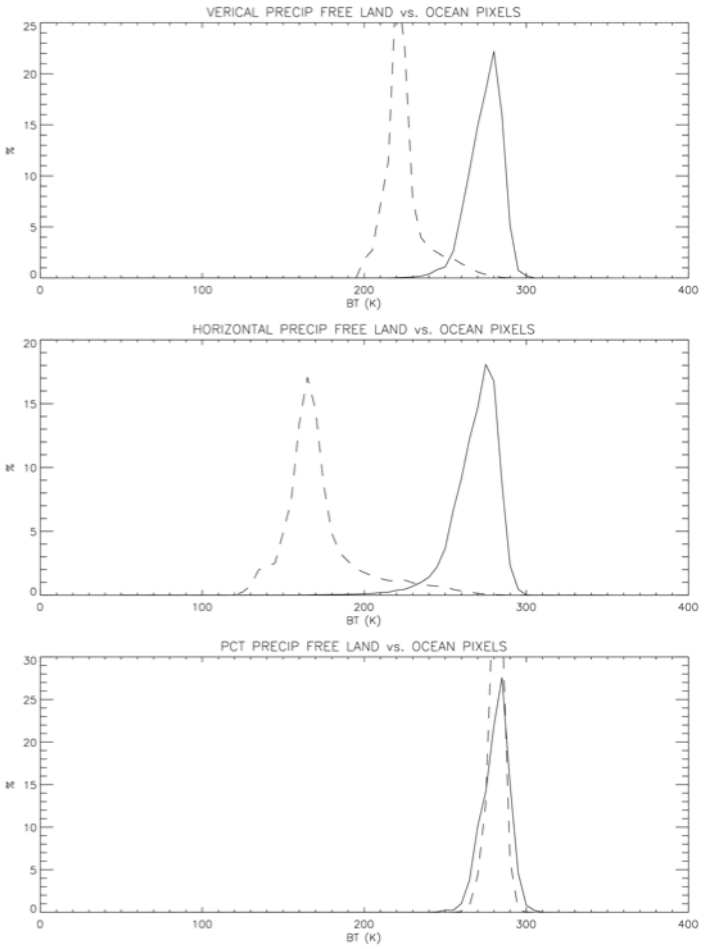
Polarization Corrected Temperature (PCT) concept

Vertically (top) and Horizontally (middle) polarized channels have very different brightness temperature distributions for rain-free pixels

Polarization Corrected Temperature (PCT; bottom) is intended to make those distributions similar to each other

$PCT = (A+1) * TB_V – A * TB_H$

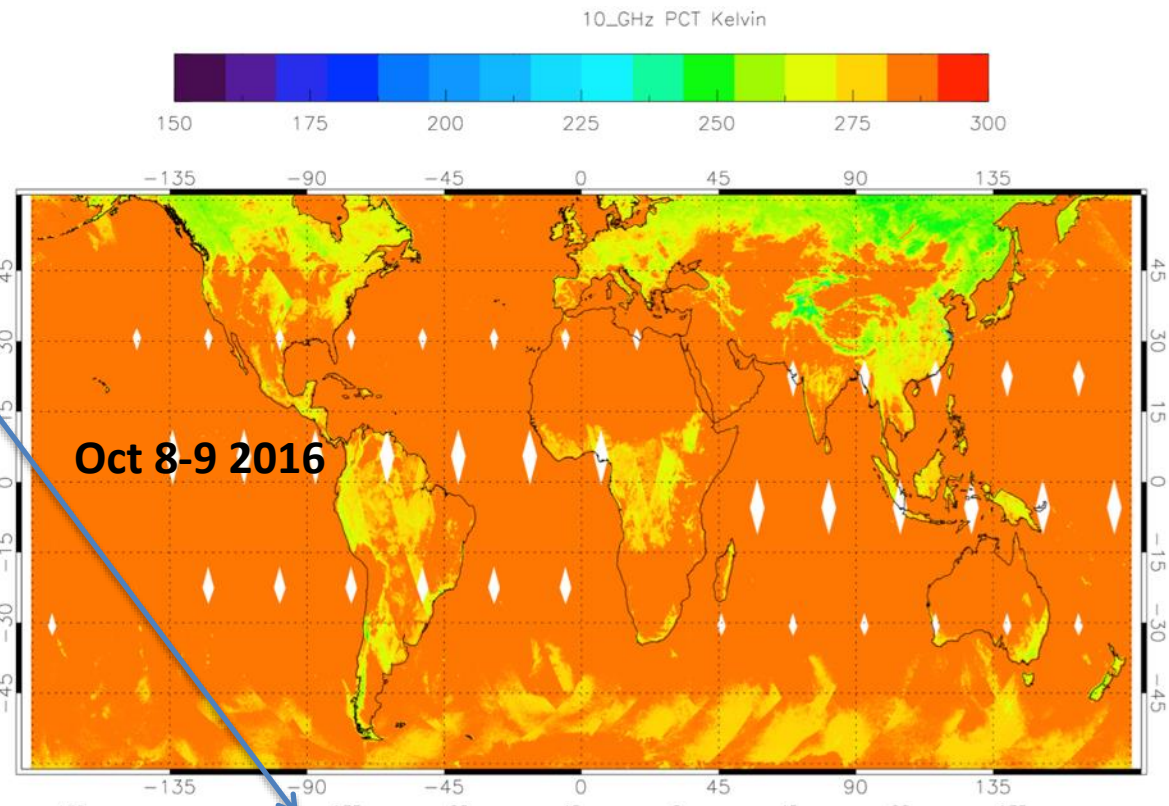
Coefficient A is empirically derived, separately for each frequency

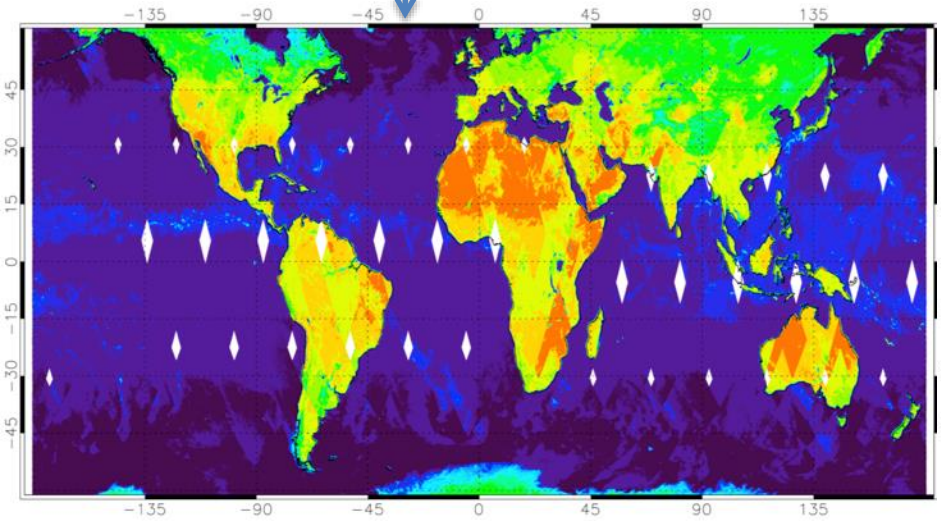


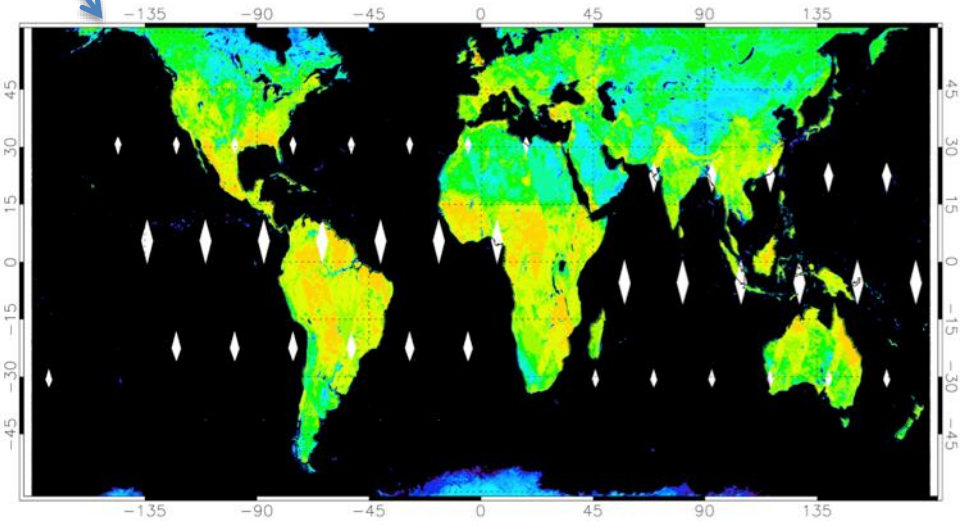
PCT should reduce Land-Water contrast

PCT10 = 2.86 * V10 – 1.86 * H10

- This also eliminates much of the precip signal, but does help highlight the strongest storms
- Might want to use this by looking at joint probabilities by PCT10 and V10



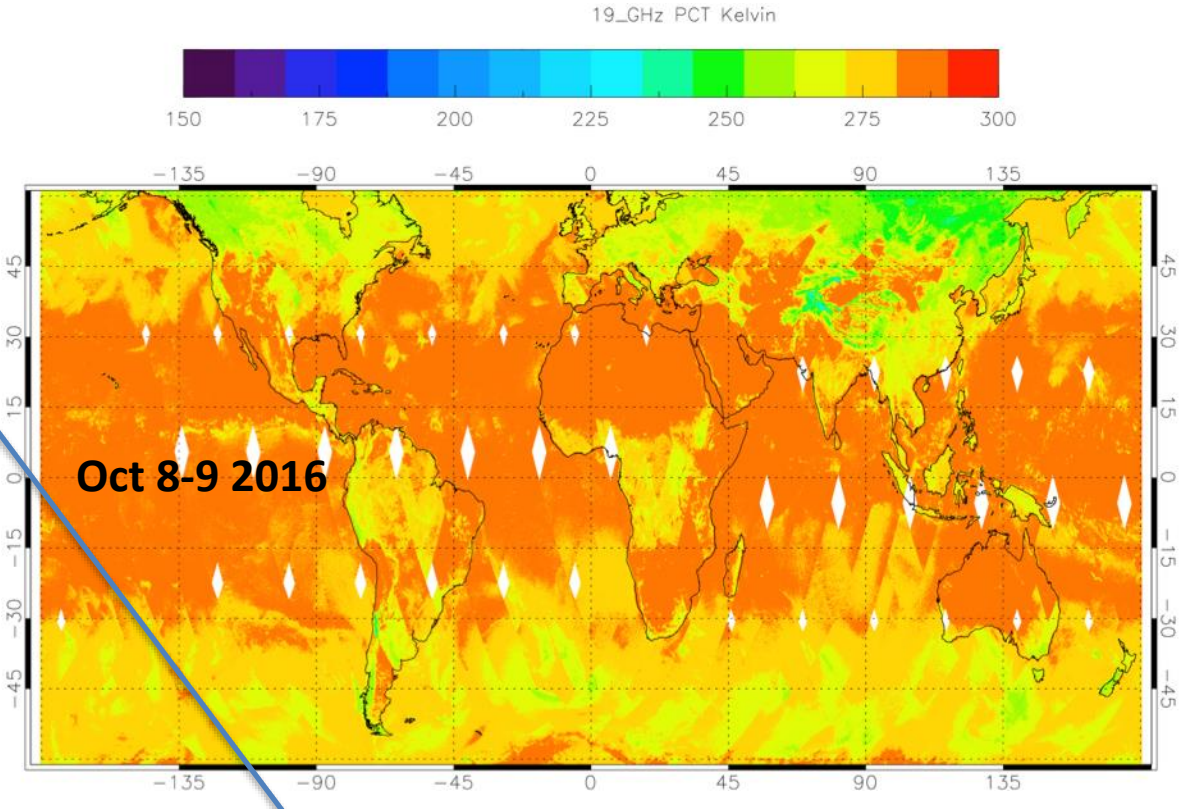


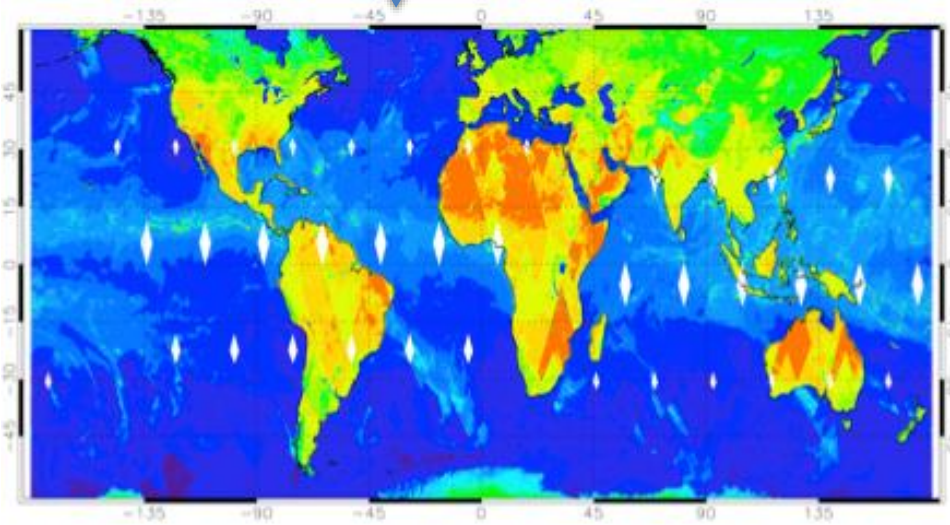


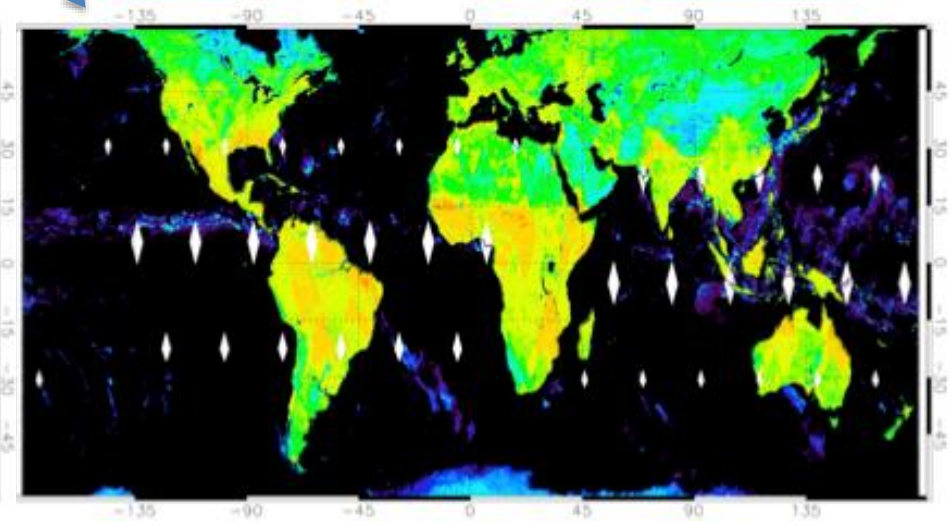
PCT should reduce Land-Water contrast

PCT19 = 2.55 * V19 – 1.55 * H19

- Some coefficient values are better for specific latitudes / seasons, but preference is to apply one value everywhere







Summary

- Combination of GMI with ground-based dual-pol radar database allows examination of Hydrometeor Type versus Brightness Temperature
- We assume that high density-ice (hail, graupel) dominates the signal if it is present somewhere in the column
- Polarization Corrected Temperature (PCT) developed for 10, 19 GHz
  - Can help distinguish very strong convection versus surface water bodies
  - 37, 89 GHz versions are already widely used, no need to replace those
  - 166 GHz, 183 GHz have little contribution from the surface any way, so little reason for PCT at those frequencies
- Using combinations of frequencies can help, but we are early in that work